ECONOMIC CONSULTING ASSOCIATES
Viewpoint

Energy-based mini-grid tariffs increase costs for customers

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Electricity mini-grids serve some of the poorest households in rural communities across the world, but the costs of supply can be high. The design of prices to the users can be important in helping to minimise those costs.

This is the third in a series of Viewpoints covering tariff regulation for electricity mini-grids in developing countries[1].

Why charge like a utility?

Low-consumption household and business customers connected to main electricity grids typically pay tariffs structured per kWh consumed. Some may pay an additional fixed charge per month, although even for modest levels of consumption, this is typically relatively small. Where utilities operate isolated systems, they may charge the same tariff level and structure as for main grid customers, creating a rationale for private mini-grids to be required to charge on the same basis.

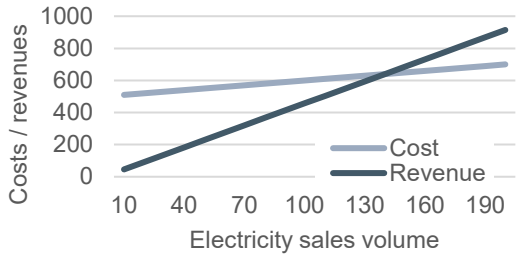
Political economy motivations lead policymakers to want to give the appearance that all customers receive a comparably 'fair' price for their electricity. They therefore also tend to prefer private mini-grid tariffs that 'look like the utility's tariffs', with a high weighting towards energy charges over fixed charges.

This is easier for policymakers, regulators, and customers to understand and to compare between mini-grid and utility tariffs. However, solely using energy-based charging is not necessarily optimal for mini-grid operators, customers, investors, or the environment, for a few reasons as discussed below.

Costs and revenues are misaligned

For solar/diesel, solar/battery, or hydro/diesel mini-grid systems, which tend to proliferate among mini-grids, most costs are fixed once the system is fully sized. That is, most of the system costs have been spent on capital assets, ie, network, solar panels, inverters, and battery storage, with relatively few running costs, except for any diesel use. The operator can therefore forecast with reasonable accuracy their costs in any one month or year, ie, fixed operating costs, recovery of capital costs, and financing costs.

To recover these costs through an average energy tariff per unit (kWh) they must divide total costs by an assumed demand for electricity. Charging based on this average tariff exposes them to demand uncertainty and insufficient revenue collection if actual demand is lower than forecast demand, as shown below (140 units of demand forecast for tariff calculation):



Such cash flow volatility translates into increased risk, which investors are likely to price into the finance they provide; when returns are less predictable, an investor will seek greater compensation in their return. This return will be incorporated in the allowed revenues as approved by the regulator, and ultimately be passed on to customers through higher electricity prices.

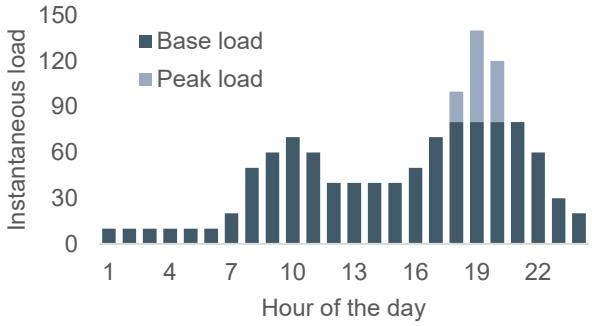
Systems may end up over-sized

Purely energy-based tariffs typically make no distinction between the time when customers consume electricity. Therefore, customers have no incentive to consume, or not consume, electricity at certain times of the day. Without

[1] The previous two covered the pros and cons of policies which require mini-grids to follow a 'national uniform tariff' and the 'reasonable costs' that could be allowed for a mini-grid subject to tariff regulation.

such a constraint, mini-grids will typically see an evening peak in their load when families return to their houses for the evening and switch on lights, fans, radios, etc.

A mini-grid developer will size their mini-grid to accommodate the peak load. If this is a solar/diesel hybrid mini-grid with an evening peak load (as shown below), the developer will choose between battery storage and diesel to provide electricity after sunlight hours. This will typically be more expensive to provide than daytime electricity directly from solar power.



A load profile with one or more peaks is likely to be more expensive to supply overall than one which is flatter. These higher costs will need to be passed on to customers. Time-of-use tariffs that allow the operator to price peak energy higher than off-peak energy can allow them to incentivise customers to shift their demand to off-peak periods, thereby lowering overall costs. While some household activities must take place in the evenings, eg, lighting, others such as phone charging can take place during the day, or some appliances, eg, fridges/freezers, can be switched off for those peak hours.

Reliability incentives are reduced

An energy-based tariff calculated across total costs effectively means that for each unit of electricity provided using a variable energy source that is more expensive than the average tariff, eg, diesel, the operator will lose money. That is, the marginal cost of providing a unit of electricity from a diesel generator is greater than the marginal benefit of revenue received from that unit.

In the absence of any enforced reliability requirement, such as a minimum number of interruptions per month, an operator has the incentive **not** to provide electricity based on more expensive generation in the evening.

There are weaker green incentives

Systems based on solar with storage are sized to meet regular demand. It is costly to provide expensive equipment that will only be used occasionally. To minimise overall costs, unusual demand is typically met through equipment with low fixed costs even though they might have higher variable costs, eg, diesel gensets.

With standard energy-only tariffs, the high costs to supply the occasional spikes in demand are shared across all customers. The price impacts of the more expensive and 'dirtier' diesel energy are therefore not fully passed on to the customers who use electricity during those spikes and there is therefore no incentive to avoid using the polluting fuels.

Technological solutions are helping

Customer connections and metering have made significant advances in both the technical capacity of a meter, and in their lower costs.

Switching customers to **fixed monthly charges** aligns costs and revenues but removes incentives for energy efficiency (avoiding appliances with large loads or switching off lights when not using them). Customer connections that incorporate **load limiters** prevent customers from using appliances with heavy loads. Similarly, **credit meters** can measure energy usage and report to customers when they are going to exhaust their credit.

Meters also have the capacity to measure energy consumption at different times of day (**time-of-use meters**). This allows a mini-grid operator to charge different prices for different times of the day, or when different (and more expensive) generation/storage solutions are engaged.

While technological solutions exist to address the challenges resulting from energy-only tariffs, they require regulatory freedom to enable operators to set prices that align incentives around costs (financial and environmental), to ultimately provide a cheaper and more reliable electricity supply to mini-grid customers.

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